Gulf Cooperation Council

EDICT OF GOVERNMENT

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GSO 215 (1994) (English): INDUSTRIAL SAFETY AND HEALTH REGULATIONS - EQUIPMENT – TANKS, PRESSURE VESSELS, BOILERS AND COMPRESSED GAS EQUIPMENT

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اشتراطات السلامة والصحة الصناعية –
الأجهزة – الخزانات وأوعية الضغط والمراجل ومعدات الغاز المضغوط

INDUSTRIAL SAFETY AND HEALTH REGULATIONS - EQUIPMENT – TANKS, PRESSURE VESSELS, BOILERS AND COMPRESSED GAS EQUIPMENT

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS - EQUIPMENT – TANKS, PRESSURE VESSELS, BOILERS AND COMPRESSED GAS EQUIPMENT

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS - EQUIPMENT – TANKS, PRESSURE VESSELS, BOILERS AND COMPRESSED GAS EQUIPMENT

1. SCOPE AND FIELD OF APPLICATION

This standard is concerned with Industrial Safety and Health Regulations - Tanks, Pressure Vessels, Boilers, and Compressed Gas Equipment.

2. COMPLEMENTARY REFERENCES

2.1 GSO 56/1987 “Industrial Safety and Health Regulations - Hazardous Materials - Gases - Part 2: Acetylene”.

2.2 Gulf standard which will be approved by GSO concerned with “lndustrial Safety and Health Regulations - Part 1: List of Contents”.

3. DEFINITIONS

3.1 Atmospheric Tank. A tank designed to operate atmospheric pressure up to 0.35 kg/sq cm.

3.2 Low Pressure Tank. A tank designed to operate at pressure above 0.35 kg/sq cm but not to exceed 1.055 kg/sq cm.

3.3 Pressure Vessel. A tank designed to operate at pressure above 1.055 kg/sq cm.

3.4 Automatic safety shutdown devices. Safety controls (other than operating controls) which monitor certain essential operating conditions of a fired boiler and which will shut down the boiler in the proper sequence when any of the essential conditions vary from set limits and require the services of the attendant to place the boiler back in operation.

3.5 Boiler: A fired pressure vessel used to generate steam pressure by the application of heat. This definition is intended to include “steam generators” and “forced-circulation boilers”.

3.6 Fired pressure vessel. A metallic vessel other than a boiler in which vapor pressure is generated in excess of 1.05 kg/sq cm by direct firing with a solid, liquid, or gaseous fuel or by electric heating elements. (This does not apply to a coil or tubular section in which a fluid or other product is being continuously circulated by means of a pump or other mechanical device, provided the pipes or tubes do not exceed 150 mm size).

3.7 High temperature water boiler. A fired pressure vessel used to heat water to temperatures above $100^{o}C$ at pressure exceeding 11.25 kg/sq cm or to temperatures exceeding $121^{o}C$ regardless of pressure.

3.8 Approach channel. Passage or passages through which gas must pass from the cylinder to reach the operating parts of the safety relief device.

3.9 Cargo tank. Any container designed to be permanently attached to any motor vehicle or other highway vehicle and in which is to be transported any compressed gas. The term "Cargo tank" shall not be construed to include any tank used solely for the purpose of supplying fuel for the propulsion of the vehicle or containers fabricated under specifications for cylinders.

3.10 Compressed gas in solution. Gas in solution (acetylene) is a nonliquefied gas which is dissolved in a solvent.

3.11 Corrosion or pitting. Loss of wall thickness by corrosive media.

3.12 Cuts, gouges, or digs. Deformations caused by contact with a sharp object in such a way as to cut into or upset the metal of the cylinder, decreasing the wall thickness at that point.

3.13 Dents. Deformations caused by the cylinder coming in contact with a blunt object in such a way that the thickness of metal is not materially impaired.

3.14 Discharge channel. Passage or passages beyond the operating parts through which gas must pass to reach the atmosphere exclusive of any piping attached to the outlet of the device.

3.15 Flow capacity. The capacity in cu m/min. of free air discharged at the required flow rating pressure.

3.16 Flow Rating Pressure. The pressure at which a safety relief device is rated for capacity.

3.17 Frangible Disc. A disc, usually of metal and which is so held as to close the safety relief device channel under normal conditions. The disc is intended to burst at a predetermined pressure to permit the escape of gas.

3.18 Free Air or Free Gas. Air or gas measured at a pressure 1.03 kg/sq cm absolute and a temperature of 16^{o}C.

3.19 Fusible Plug. A plug of suitable low melting material, usually a metal alloy, which closes the safety relief device channel under normal conditions and is intended to yield or melt at a predetermined temperature so as to permit the escape of gas.

3.20 General Corrosion. Corrosion which covers considerable surface areas of the cylinder. It reduces the structural strength. It is often difficult to measure or estimate the depth of general corrosion because direct comparison with the original wall cannot always be made. General corrosion is often accompanied by pitting.

3.21 High and Low-Pressure Cylinders. High - pressure cylinders are those cylinders with a marked service pressure of 63.3 kg/sq cm or greater. Low-pressure cylinders are those with a marked service pressure less than 63.3 kg/sq cm.

3.22 Isolated Pitting. Pits of small cross-section which do not effectively weaken the cylinder wall but are indicative of possible complete penetration and leakage. Since the pitting is isolated the original wall is essentially intact.

3.23 Line Corrosion. Pits which are not isolated but are connected or nearly connected to others in a narrow band or line. This condition is more serious than isolated pitting. Line corrosion frequently occurs in the area of intersection of the footing and bottom of a cylinder. This is sometimes referred to as "Crevice corrosion".

3.24 Liquefied Compressed Gas. A gas which under the charging pressure, is partially liquefied at a temperature of 21°C. A flammable compressed gas which is normally nonliquefied at 21°C but which is partially liquefied under the charging pressure and temperature, shall follow the requirements for liquefied compressed gases.

3.25 Nonliquefied Compressed Gas. A gas, other than a gas in solution which under the charging pressure, is entirely gaseous at a temperature of 21°C.

3.26 Portable Tank. Any container designed primarily to be temporarily attached to a motor vehicle, car or railroad car other than a tank car or marine vessel, and equipped with skids, mountings, or accessories to facilitate handling of the container by mechanical means, in which any compressed gas is to be transported. The term "Portable tank" shall not be construed to include any cargo tank, or any tank of a tank-car.

3.27 Pressurized Liquid Compressed Gas. A compressed gas other than a compressed gas in solution, which cannot be liquefied at a temperature of 21°C, and which is maintained in the liquid state at absolute pressure not less than 2.8 kg/sq cm by maintining the gas at a temperature less than 21°C.

3.28 Rated bursting pressure. Maximum pressure for which the disc is designed to burst when in contact with the pressure opening for which it was designed when tested.

3.29 Reinforced fusible plug. A fusible plug consisting of a core or suitable material having a comparatively high yield temperature surrounded by fusible metal of low-melting point suitable for yield temperature.

3.30 Safety relief device. Device intended to prevent rupture of a cylinder under certain conditions of exposures. (The term as used herein shall include the approach channel. the operating parts. and the discharge channel).

3.31 Safety relief device channel. Channel through which gas released by operation of the device must pass from the cylinder to the atmosphere exclusive of any piping attached to the inlet or outlet of the device.

3.32 Set pressure. The pressure marked on the valve and at which it is set to start-to-discharge.

3.33 Start-to-discharge pressure. The pressure at which the first bubble appears through a water seal of not over 102 mm on the outlet of the safety relief valve.

3.34 Yield temperature. The temperature at which the fusible metal or alloy will yield when tested.

4. REGULATIONS

4.1 Tanks and pressure vessels.

4.1.1 General

4.1.1.1 All tanks and vessels are to be designed, fabricated, tested and stamped in compliance to good engineering practices.

4.1.1.2 The normal operating conditions of the tank or vessel shall not exceed the design pressure or temperature.

4.1.1.3 Any internal bracing will include vent holes to prevent the forming of gas pockets or liquid pools when liquid level rises or falls.

4.1.1.4 The smallest dimension on any manhole will not be less than 400 mm circular or 280 x 400 mm oval or 255 x 410 mm oval.

4.1.2 Supports and Foundations

4.1.2.1 Tank and vessel supports shall be installed on firm foundations. Tank supports shall be of concrete, masonry, or steel.

4.1.2.2 Tanks without supports shall rest on the ground or on foundations made of concrete, masonry, piling or steel.

4.1.3 Corrosion Protection. Corrosion protection for the tank and its piping shall be provided by one or more of the following methods:

4.1.3.1 Use of protective coatings or wrappings.

4.1.3.2 Cathodic protection; or

4.1.3.3 Corrosion - resistant materials of construction.

4.1.4 Normal venting

4.1.4.1 Atmospheric tanks shall be vented to prevent the development of vacuum pressure sufficient to distort the tank or exceed the design pressure as a result of filling or emptying, and atmospheric temperature changes.

Normal vents shall be sized in accordance with good engineering practice or shall be at least as large as the filling or withdrawal connection, whichever is larger but in no case less than 30 mm inside diameter.

4.1.4.2 Low-pressure tanks and pressure vessels shall be vented to prevent development of pressure or vacuum, as a result of filling or emptying and atmospheric temperature changes, for exceeding the design pressure of the tank or vessel. Protection shall also be provided to prevent overpressure.

4.1.4.3 If any tank or pressure vessel has more than one fill or withdrawal connection that simultaneous filling or withdrawal can be made. the vent size shall be based on the maximum anticipated simultaneous flow.

4.1.5 Repair or Modification

4.1.5.1 Tanks and vessels may be used for other purposes, provided they do not show any harmful corrosion or damage and comply with above requirements.

4.1.5.2 Any physical work other than that permitted by it's code, (drilling, welding, etc) to tank or vessel after stamping shall be approved by qualified personnel to maintain the integrity of stamp.

4.1.6 Identification of Tanks and Vessels. Each stationary tank or vessel containing flammable, - combustible, corrosive, or toxic substances shall be identified by a letter, number, name or combination of these. The identifications shall, when practical, be located so as to be legible from the location at which the tank or vessel is operated or controlled. Identifications shall be maintained so as to be legible.

4.1.7 Vessel Record. A permanent and progressive record for each vessel shall be maintained at the plant or the field office where the vessel is located. The record shall be available for inspection by concerned authorities and shall include the following:

- The serial or identification number of the vessel.
- The established safe working pressure of the vessel for the working temperature.
- Relief valve setting.
- The maximum working temperature.
- Manufacturer's data reports, when obtainable, and all data pertaining to tests, inspections and calculations used in establishing the safe working pressure.

4.1.8 Pressure Relieving Safety Devices on Vessels

4.1.8.1 The employer shall maintain each pressure-relieving safety device installed on operating equipment so as to insure the proper functioning of the device at the intended pressure. Such maintenance shall include testing, inspection, and the repair of the pressure-relieving safety devices. Pressure-relieving safety devices and discharge lines shall not be tampered with. The pressure settings shall not be changed by employees other than those definitely assigned to such duties by the employer, and such assigned employees shall have available or shall obtain the necessary facts so that any increased setting will be within the requirements of this section.

4.1.8.2 Safety relief valves installed on pressure vessels shall be constructed, installed, and maintained in accordance with good engineering practice.

4.1.8.3 No pressure vessel shall be operated in excess of the allowable working pressure of the vessel as established by codes or the maximum allowable working pressure as established for the vessel at its last inspection, whichever is the least. Pressure-relieving devices shall be set to prevent the pressure from rising more than 10% above the maximum allowable working pressure.

Exception: Any pressure vessel which contains a flammable, poisonous, irritating or noxious substance which would, if released to atmosphere, create a hazard, may have its safety relief valve or vapor pressure-relieving devices set higher so that the pressure can not rise higher than 120 percent of the allowable working pressure of the vessel, but in no case shall said vessel or vessels be operated in excess of their allowable working pressure.

4.1.8.4 A permanent and progressive record of pressure-relieving safety devices in service, showing the serial or identification number, the location, the pressure setting, the free orifices area in sq cm, the date of installation in service, and the date of testing shall be maintained at the plant or field where the pressure-relieving safety device is located or at the supervising office.

4.1.8.5 A vessel having a stop valve that shuts off the vessel from its pressure-relieving device, as permitted in item 4.1.8.3, shall be protected by an additional safety device, if the vessel may become entirely filled with liquid and if it is possible that pressure may be generated by continued input of heat through exchanger tubes or similar devices, or by exposure to sun or adjacent hot equipment. This additional safety device shall be connected to the vessel at all times except as permitted in item 4.1.8.8. The additional safety device may be set higher so that the pressure can not rise higher than 120 percent the safe working pressure.

4.1.8.6 A vessel in which pressure can be generated because of service conditions shall have no stop valve between the vessel and its pressure-relieving device except for inspection or repair purposes, as permitted in item 4.1.8.8, and except in cases where multiple pressure-relieving devices are provided and the stop valves are so constructed that they can not be operated so as to reduce the pressure-relieving capacity below that required.

4.1.8.7 A vessel in which the pressure originates from an outside source exclusively may have its pressure-relieving device on the vessel or at any point on the system between the vessel and its source of pressure, provided that the pressure-relieving device is set to function at not over the safe working pressure of the vessel. Under these conditions there may be a stop valve between the vessel and the pressure-relieving device which need not be locked open if the stop valve also closes the vessel from its source of pressure. Any stop valve between the pressure relieving device and the vessel, which does not close the vessel from its source of pressure, shall meet the requirements given in item 4.1.8.6.

4.1.8.8 A vessel may have a stop valve between it and its pressure-relieving device for use in inspection and repair, in which case the stop valve shall be locked or sealed open and shall not be closed except by a person definitely assigned to such duties by the employer. This authorized person may close the valve if it remains at a location where the operating pressure is observed and an arrangement has been provided for relieving the pressure in the event of over pressure. This person shall replace the safety device and again lock or seal the stop valve in the open position before leaving the location.

4.1.8.9 Stop valves as permitted above shall not be gate valves or globe valves installed so that the disk will open against the pressure, except that this limitation need not apply to stop valves closing the vessel from its source of pressure.

4.1.8.10 The aggregate capacity of the pressure-relieving safety devices applied to any vessel or system of vessels for the release of vapor shall be sufficient to carry off the maximum quantity of vapor that can be generated in, or supplied to, the attached equipment within the variations of normal operation, without permitting a rise in pressure within the vessel of more than 16 percent above the safe working pressure.

4.1.8.11 Safety valves or devices designed to relieve hydrostatic pressure caused by heat as outlined under item 4.1.8.5, shall have sufficient relieving capacity to prevent a hydrostatic pressure within the vessel in excess of 120 percent of the safe working pressure.

4.1.8.12 Outlets from pressure-relieving safety devices shall be properly secured and shall lead to a safe place of discharge. Pressure-relieving safety device stacks which are open to the atmosphere shall be provided with a drain. The size of outlets or stacks shall be such that any pressure drop shall not reduce the relieving capacity of the relieving devices below that required to protect the vessel. No stop valve shall be placed on a discharge line from a pressure-relieving safety device except when such discharge line discharges to a common header, in which case such stop valve shall be locked or sealed open and shall be closed, while the vessel is in operation, only by a person definitely assigned to such duties by the employer, and such person shall not leave the location until the stop valve is opened and relocked or resealed.

4.1.8.13 The employer shall maintain each pressure-relieving safety device installed on operating equipment so as to insure the proper functioning of the device at the intended pressure. Such maintenance shall include inspection, testing, and the repair of the pressure-relieving safety devices at frequencies as required by the service conditions.

4.1.8.14 Each pressure-relieving safety device in service shall have serial or identification number stamped upon it and in addition a metal plate or metal tag shall be attached to each such device and shall show the pressure setting and the date the device was installed in service.

4.1.9 Roofs and Walkways

4.1.9.1 The roofs of tanks shall be capable of safely supporting employees required to go onto the roofs for inspection or maintenance purposes. When it is necessary for employees to gauge, sample or perform other operating duties at a tank roof level, or on the roofs of tanks, safe access shall be provided to the roof. Locations on tank roofs where operating duties are performed shall be provided with safe platforms and safe access thereto. A walkway will be accepted as a safe platform when the operating duties are performed entirely from the walkway.

4.1.9.2 Where the means of access, the walkways, or the platforms of a group of two or more tanks are connected, there shall be provided unobstructed stairways, ramps, fixed ladders, walkways or crosswalks to permit an employee to escape from the roof, walkway or platform of any other tank in the group in the event the walkway or platform of any other tank in the group becomes impassable due to fire or other emergency. This subparagraph shall not apply to tanks containing water, tanks containing petroleum products having an open cup flash point above 150^{o}C, or in the case of fuel oils, and where such tanks are isolated from tanks, pipelines and other equipment containing gases, light oils, corrosives or liquids stored at a temperature above 66^{o}C.

4.1.9.3 Walkways on tank roofs shall be not less than 60 cm in width. It shall be permissible to install midrails and toeboards within this width provided a minimum clear width of 50 cm shall be maintained. Walkways shall be designed

to carry the load to the supporting structure of the tank roof and shall be securely attached to the tank. Walkways constructed of steel shall have a nominal thickness not less than 3 mm and painted to protect them from atmospheric corrosion.

4.1.9.4 Tank roofs, platforms, walkways and stairways shall be kept clear of loose material or equipment except that sampling and gauging equipment may be kept on tank roofs in special racks or containers.

4.1.9.5 When in the open position, the covers of gauges, sampling and manhole openings in tank roofs shall be securely attached to the roof or roof opening fixture. Attachment may be by hinge, chain, bolts, or other means which will prevent their falling from the tank. This subparagraph shall not apply when such covers are so confined that when removed from their openings they cannot fall or be blown by the wind from the tank.

4.2 Boilers and Fired Pressure Vessels.

4.2.1 Design and Construction. All fired pressure vessels shall be constructed, inspected, and stamped in accordance with good engineering practice for the pressure and temperature to be expected in service with a factor or safety of at least four.

4.2.2 Installation

4.2.2.1 Each power boiler, and high temperature water boiler shall have safety valves or pressure relieving devices constructed, stamped, and installed in accordance with good engineering practice.

4.2.2.2 Boilers (or vaporizers) of the Dowtherm, mercury vapor or similar types shall be fitted with adequate safety relieving devices to assure their safe operation. Safety valves of Dowtherm vaporizers and similar equipment shall be removed at least once each year for inspection and cleaning of any deposits that might affect their operation. (To eliminate the necessary of shutting down of the unit for this inspection, a 3-way stop valve may be installed under 2 safety valves, each with the required relieving capacity, and so installed that both safety valves cannot be closed off from the vaporizer at the same time; or 2 or more separate safety valves may be installed with individual shut-off valves, in which case the shut-off valve stems shall be mechanically interconnected in a manner which will allow full required flow at all times).

4.2.2.3 Fired pressure vessels other than those mentioned in item 4.2.2.2 above shall be fitted with safety relieving devices of sufficient caposity to relieve all vapor that can be generated in the vessel during normal operation and shall be fitted with proper controls to assure their safe operation.

4.2.2.4 All boilers shall have blow-off valves and piping installed in accordance with good engineering practice.

4.2.2.5 All blow-off pipes shall terminate at a safe place of discharge and shall be adequately supported to prevent undue stresses on the valves or lines, and shall not be reduced in size between the blow-off valve and point of discharge.

4.2.2.6 Blow-off valves constructed with integrally threaded bonnets shall not be permitted.

4.2.2.7 Blow-off tank when used shall be designed and constructed in accordance with good engineering practice for the maximum pressure and temperature expected during the blowdown period with a factor of safety of at least 4. All blowoff tanks shall be provided with means for cleaning and inspection.

4.2.2.8 All power boilers shall be equipped with at least one means for feeding water to the boiler at the maximum allowable pressure. Boilers having more than 46 sq m of water heating surface shall have at least 2 means of feeding. A water supply system may be considered as a means of feeding water to the boiler where the water pressure in the system is not less than 6 percent above the pressure at which the safety valve is set to open. Feed piping, valves, and appurtenants shall be installed as required by good engineering practice.

4.2.2.9 All power boilers and high-temperature water boilers shall be equipped with water gauges and pressure gauges.

4.2.2.10 An access opening of the following dimensions shall be provided in the hood where it is impracticable to remove the hood of any vertical fire-tube boiler for inspection purpose:

4.2.2.10.1 For boilers not exceeding 91 cm diameter, not less than 15 cm by 20 cm or equivalent area with a minimum dimension of 15 cm in any direction.

4.2.2.10.2 For boilers over 91 cm diameter, not less than 30 cm by 40 cm or equivalent area with a minimum dimension of 28 cm in any direction and a minimum diameter of 38 cm for circular openings.

4.2.2.11 Access for inspection and cleaning shall be provided in all boiler settings. The minimum dimension of access openings shall be 30 cm by 40 cm, unless the size and/or design of the boiler setting is such that inspection and cleaning can be adequately accomplished through smaller openings.

4.2.2.12 Each boiler having a manhole opening shall be fitted with 2 stop valves between the boiler and the common main or header when 2 or more steam, high-temperature water, or hot water heating boilers having manhole openings are installed m battery or connected to a common main or header. A free blow drain shall be provided between the stop valves and the discharge from the drain shall be visible to the operator while manipulating the drain valve.

4.2.3 Inspection

4.2.3.1 Boilers Subject to Annual Inspection

4.2.3.1.1 All boilers are subject to annual internal and external inspection except as provided in items 4.2.3.1.2 and 4.2.3.2.

4.2.3.1.2 Boilers installed in turboelectric plants in such a manner that each boiler furnishes steam to a single turbine only shall be inspected internally at least once each 18 months. The permit to operate issued following internal inspection shall expire not more than 12 months after the date of inspection. The boiler shall be externally inspected prior to or on the expiration date of the permit by a qualified inspector who may, if conditions warrant, issue a temporary permit which shall expire not

more than 6 months after the date of external inspection. A copy of the external inspection report shall be forwarded to GSMO by a qualified inspector. Such report shall show the expiration date of the temporary permit to operate.

4.2.3.1.3 GSMO upon individual application from petroleum companies, chemical plants, public utilities or other industries considered by GSMO as having superior preventive maintenance and examination programs, may grant a maximum interval of 24 months between internal inspection of fired boilers. A fired boiler is defined for this subparagraph as one whose temperature input can cause metallurgical damage to the boiler, or whose combustion of fuel can cause a furnace explosion. For boilers other than fired boilers, OSMO may grant a maximum interval of 36 months between internal inspections, provided the temperature input cannot cause metallurgical damage. Such applications, to be reviewed by GSMO shall contain as a minimum the following information and proposals: The history of the unit (or of a similar installation) that shows that there is no significant deterioration from scaling, corrosion, erosion or overheating.

4.2.3.1.4 Wall thickness reference points shall be established. Following internal inspection of each boiler, a complete record showing the total corrosion and any other conditions found which need correction at the tiine of inspection shall be forwarded to GSMO. This record shall show the location and extent of any corrosion, erosion or other defects noted and shall be verified and signed by the certified inspector making the inspection required by item 4.2.3.1.1.

The “Permit to operates shall expire 1 year from the date of the internal inspection, or the date of startup if so noted on the inspection report and the “Permit to operate”. Prior to or on the expiration date of this “Permit”, the boiler shall be inspected externally by a certified inspector, who will review the operating logs and water treatment records. If conditions warrant, the certified inspector may issue a temporary permit not to exceed 6 months. Prior to or on the expiration date of the second permit, the boiler shall again be inspected externally by a certified inspector; if conditions wannat, a “Permit” may be issued for an additional 6 months.

4.2.3.1.5 Boilers operating longer than 24 months between internal inspections shall have a program of onstream examination of corrosion points, and inspection of operations and safety controls that is acceptable to the concerned authorities and the certified inspection agency. The maximum interval of each temporary permit shall be 6 months. The certified inspector shall submit reports of each external inspection to GSMO, noting the expiration date of the permit issued, and recording any unusual condition found. The inspection report shall include a statement that water treatment records have been reviewed.

4.2.3.1.6 Reports of onstream wall thickness readings must also be submitted to GSMO by the certified inspector.

4.2.3.1.7 The boiler water treatment and specific chemical limits shall be prescribed by a competent water treatment specialist. The boiler water chemistry shall be maintained within desirable limits and documentary records shall be kept of the tests and methods used to maintain the water chemistry within the prescribed limits. A summary of weekly tests results shall be kept, and the records shall be available to the certified inspector.

4.2.3.1.8 A copy of GSMO letter granting the longer interval between internal inspections shall be posted near the boiler, the boiler control center, or the process unit control room.

4.2.3.2 Boilers Not Subject to Annual Inspection

4.2.3.2.1 The following boilers are not subject to annual inspection and do not require a permit to operate:

- High-temperature water boilers.
- Boilers. including forced circulation boders, in which none of the following are exceeded:
- 9.3 sq m of heating surface.
- Steam drum does not exceed 40 cm inside diameter.
- Maximum allowable working pressure does not exceed 7 kg/sq cm.
- Water capacity does not exceed 0. 13 cu. m when filled to normal operating level.
- The heat input to the burners does not exceed 422.000 kilojoules/hr.

4.2.3.2.2 Boiler exempt from annual inspection in subparagraph 6.5.4.2.1 shall comply with all of the following:

- All other provisions of these subparagraphs including construction and installation.
- All automatic controls shall be maintained in operating condition.

4.2.3.2.3 Nothing in items 4.2.3.2.1 and 4.2.3.2.2 shall prohibit any qualified safety engineer employed by the concerned authorities from requiring any boiler to be prepared for inspection when in his opinion such inspection is necessary to determine the safety of the boiler.

4.2.3.3 Preparation of Boilers for Inspection

4.2.3.3.1 The owner or user of a boiler or boilers herein required to be inspected shall, after 14 days' notice from the concerned authorities, prepare the boiler for internal inspection.

If the owner or user finds the date set for inspection not to his convenience, he shall immediately advise the concerned authorities or qualified inspector, and ask for a postponement and state the reasons therefor, in which case the inspection date may be postponed for a period not to exceed 30 days from the date first set for inspection.

4.2.3.3.2 To prepare a boiler for internal inspection the water shall be drawn off and the boiler thoroughly washed. Manhole and handhold covers and washout plugs in the boiler feed lines and water column connections necessary for adequate inspection shall be removed and the furnace and combustion chamber thoroughly cooled and cleaned. Enough of the brickwork, refractory, or insulating material shall be removed to permit the qualified inspector to determine the condition of the boiler, furnace, or other parts to enable the qualified inspector to obtain such data as is required at each annual inspection. The steam gauge shall be removed

for testing. At the discretion of the concerned authorities, data obtained by non-destructive examination may be used in lieu of visual inspection.

4.2.3.3.3 The owner or user shall prepare the boiler for hydrostatic test when required by the qualified inspector. If the boiler to be hydrostatically tested is connected with other boilers that are under steam pressure, such connections shall be blanked off unless provided with double stop valves with a free blow drain between the valves. Test water to be used shall not contaminate the system.

4.2.3.3.4 Before a resale inspection or other inspection of a second hand boiler is made, the interior of the shell or drum may be required to be descaled and cleaned, such tubes shall be removed as the qualified inspector deems necessary to enable him to ascertain their condition, the lagging and brickwork shah be removed, and the exterior of the shell or drum shall be cleaned. No paint shall be applied before the inspection is made.

4.2.3.3.5 All float chambers of automatic controls shall be dismanteled for the annual inspection.

4.2.3.4 Identification of Boilers

4.2.3.4.1 Qualified inspectors making the first field inspection of boilers to have a permit to operate, shall stamp on the boiler a serial number (unless a serial number has previously been stamped thereon) which shall become a permanent means of identification. This assigned number shall be made either by steel die figures no less than 8 mm in height, or outlined by means of center punch dots, with figures not less than 19 mm in height, and shall be stamped adjacent to the manufacturer's code stamping.

4.2.3.4.2 No serial number or code stamping shall be permanently covered by insulating material, unless such number and stamping is transferred to a fixed plate which is readily visible outside of all insulating material.

4.2.3.5 Certification of Inspectors

4.2.3.5.1 Upon the written request of his employer, a certificate of competency may be issued to a person who is employed as provided in item 4.2.3.5.3 and who obtains a passing grade in the examination prescribed by GSMO. The prescribed examination shall determine the fitness and competency of any candidate for this certificate.

4.2.3.5.2 An applicant for a certificate of competency shall be at least 25 years of age and shall have had at least 3 years experience in boiler or unfired pressure vessel construction or repair or as an operating engineer in charge of high-pressure boilers, or as inspector of steam boilers or unfired pressure vessels. Technical education with a recognized degree in engineering shall be allowed 2 years as the equivalent of practical experience.

4.2.3.5.3 A certificate of competency may be issued to a person formerly employed as an inspector of steam boilers or pressure vessels, or to an inspector continuously employed by a corporation or company to inspect only boilers and pressure vessels to be used by such company and not for resale. The certificate of competency shall be automatically revoked after a period of 18 months if the inspector does not make any boiler or pressure vessel inspections as evidenced by reports

submitted to the division; provided, however, that this provision does not apply to supervising engineers whose regular duties include the supervision and review of the work of qualified inspectors. A written examination is required to revalidate such certificate. The employer shall notify GSMO when the employment of a certified inspector is terminated.

4.2.4 Operation

4.2.4.1 Permit to Operate

4.2.4.1.1 Except during the time that a request for a permit remains unacted upon, no boiler subject to annual inspection by these orders shall be placed in operation until a permit to operate has been issued and posted on or near the boiler.

4.2.4.1.2 Upon the form supplied by the concerned authorities, a permit to operate shall be issued by the qualified inspector making the inspection. The permit to operate shall indicate the date of inspection, serial number of the boiler, the pressure allowed at the time of the internal inspection, the name of the inspector, and the name of the inspection agency. No permit shall be issued until the boiler is in compliance with these Safety Standards and satisfactory notice of compliance has been transmitted to the concerned authorities.

Exception: The concerned authorities may issue and renew temporary permits not to exceed 30 days each, to permit replacements or repairs to be made.

4.2.4.1.3 Each permit shall be posted under glass in a conspicuous place on or near the boiler. The permit shall be available to any safety engineer employed by the concerned authorities. The permit to operate shall expire when a boiler changes both ownership and location.

4.2.4.2 Attendance on Boilers

4.2.4.2.1 All boilers shall be under the direct supervision of a responsible person trained in boiler operation. Such person shall be responsible for:

Safe operation of the boiler by a competent attendant.

Proper maintenance of the boiler and its appurtenants.

4.2.4.2.2 While in operation, no fired boiler (except those boilers exempted from annual inspection by item 4.2.3.2) shall be left unattended for a period of time longer than it will take the water level to drop from the normal operating level to the lowest permissible water level in the water gauge glass - or indicated by indicating devices or recorders - when the feedwater is shut off and the boilers are forced to their maximum capacity unless all of the following are complied with:

The boiler is equipped with an audible alarm that win operate when the water reaches the highest and lowest permissible operating level, or, for boilers having no fixed steam or water line, when the highest permissible operating temperature is reached.

The audible alarm shall be sufficiently loud that it can be plainly heard by the attendant, without the use of an auxiliary paging system, at any point in any area that the attendant is required to work. He must be close enough to the boiler room so that he can safely respond to the alarm. The response time is that period of

time that it takes the water level to go from the level at which the low level alarm sounds down to the lowest permissible water level of the boiler.

4.2.4.2.3 The high water level alarm must be set so that the attendant will have time to respond before there will be carryover from the boiler.

4.2.4.2.4 The boiler is equipped with a low water safety-valve that will shut off the fuel to the burner(s) when the water reaches the lowest permissible operating level, or, for boilers having no fixed steam or water line, when the highest permissible operating temperature is reached. This device shall require manual resetting unless the pilot is equipped with a full safety pilot control.

4.2.4.2.5 The attendant shall personally check the operation of the boiler, the necessary auxiliaries, flame management control system and the water level in the boiler at such intervals as are necessary to insure the safe operation of the boiler; provided, however, that the maximum interval the boiler and its auxiliaries can be left without checking shall not exceed 60 minutes.

4.2.4.2.6 The operation of the automatic controls shall be checked at the beginning of each shift. The use of time clocks to control the operation of fired boilers covered under item 4.2.4.2.2 is prohibited.

4.2.4.3 The competent attendant shall be a person who is familiar with the boiler and who has been properly instructed in its safe operation.

4.2.4.4 The recommended minimum standards to be used by the employer to determine the competency of an attendant are:

- He shall be able to explain the function and operation of all controls on the boiler or boilers.
- He shall be able to light off the boiler or boilers in safe manner.
- He shall know all possible methods of feeding water to the boiler or boilers.
- He shall know how to blow down the boiler or boilers in a safe manner.
- He shall know what would happen if the water is permitted to drop below the lowest permissible operating level.
- He shall know what would happen if the water in the boiler was carried too high.
- He shall know how to shut down the boiler or boilers.

4.2.4.5 An oil field recovery heater designed for automatic operation shall be checked by a competent attendant at least once every 24 hours while in operation to determine that the heater is operating safely within the set operating conditions and provided that each of the following are complied with:

4.2.4.5.1 The heater is equipped with automatic safety devices for each of the following conditions:

Excessive tube skin or steam temperature;

Excessive steam pressure;

Flame failure;

Inadequate combustion air;

4.2.4.5.2 Within intervals not to exceed every 60 days of operation of the heater, the following inspection checks shall be performed by a person familiar with the equipment and who has been properly instructed in making such checks:

Each safety shutdown device shall be tested for proper operation;

All external piping and wiring shall be visually checked for obvious defects;

All indicating gauges shall be checked for proper calibration;

Equipment defects found above shall be corrected before continuing the boiler in service.

4.2.4.5.3 At the time of the annual inspection of the heater and its accessory equipment, all automatic operating controls and automatic safety shutdown devices which are not failsafe shall be serviced as necessary to assure their continued reliability to include:

Replace vacuum tubes and check sensing devices in the flame-failure system and replace if not operating properly.

Test all coils, diaphragms, and other operating parts of all safety shutdown and operating control valves.

Such servicing shall be done by a person familiar with such controls and devices and who has been properly instructed in their servicing.

4.2.4.5.4 A record shall be kept of the inspection and maintenance operations required above and this record shall be available to the certified inspector at the time of the annual inspection.

4.2.5 Safe Practices

5.2.5.1 All fired boilers, not included in item 4.2.3.2, equipped with controls to permit the burners to be ignited automatically shall be equipped with a full safety pilot or other device that will provide equivalent safety. Such safety pilot or other devices shall be of a type that will de-energize the electrical circuit and/or cause the main burner fuel valve to close within the following burner input and time limits:

422000 kilojoules/hr and under ..... 90 seconds

422000 to 2,637, 640 Kilojoules/hr ..... 9 seconds

Over 2,637, 640 Kilojoules/hr ..... 5 seconds

4.2.5.2 All dampers used in smoke-stacks of boders which use natural draft shall have suitable openings to vent the furnace.

4.2.5.3 When portable electric lights are used inside any boiler or pressure vessel they shall be equipped with a vapor-tight globe, substantial guard, rugged non-conducting lamp holder and handle, and cord sufficiently long to reach to a plug-in or junction box outside the vessel.

4.3 **Compressed Gas Equipment**

4.3.1 Inspection procedures for compressed gas cylinders

4.3.1.1 General

4.3.1.1.1 Each employer shall determine that compressed gas cylinders under his control are in a safe condition to the extent that this can be determined by visual and other inspection required.

4.3.1.1.2 Experience in the inspection of cylinders is an important factor in determining the acceptability of a given cylinder for continued. service. Users lacking this experience and having doubtful cylinders shall return them to a manufacturer of the same type of cylinders for re-inspection or to a local certified inspection and testing agency.

4.3.1.2 Inspection of Low-Pressure Cylinders Exempt From the Hydrostatic Test Including Acetylene Cylinders

4.3.1.2.1 This subparagraph covers cylinders that are exempt from the hydrostatic retest requirements by virtue of their exclusive use in certain non-corrosive gas service. They are not subject to internal corrosion and do not require internal shell inspection.

4.3.1.2.2 Rust, scale, caked paint, etc., shall be removed from the exterior surface so that the surface can be adequately observed. Facilities shall be provided for inverting the cylinder to facilitate inspection of the bottom. Experience has shown this area to be the most susceptible to corrosion.

4.3.1.2.3 Cylinders shall be checked as outlined below for corrosion, general distortion, or any other defect that might indicate a weakness which would render it unfit for service.

4.3.1.2.3.1 Defected if the tare weight is less than 95 percent of the original tare weight marked on the cylinder. When determining tare weight be sure that the cylinder is empty.

4.3.1.2.3.2 Defected if the remaining wall in an area having isolated pitting only is less than one-third of the minimum allowable wall thickness as determined under items 4.3.1.2.4 and 4.3.1.2.5.

4.3.1.2.3.3 Defected if line corrosion on the cylinder is 75 mm in length or over and the remaining wall is less than three-fourths of the minimum allowable wall thickness or when line corrosin is less than 75 mm in length and the remaining wall thickness is less than one-half the minimum allowable wall thickness as determined by items 4.3.1.2.4 and 4.3.1.2.5.

4.3.1.2.3.4 Defected if the remaining wall in an area of general corrosion is less than one-half of the minimum allowable wall thickness as determined by items 4.3.1.2.4 and 4.3.1.2.5.

4.3.1.2.4 When the wall thickness of the cylinder at manufacture is not known, and the actual wall thickness cannot be measured, this cylinder shall be rejected when the inspection reveals that the deepestt pit in a general corrosion area exceeds 1 mm. This is arrived at by considering that in no case shall the pitting exceed one-half the minimum allowable wall thickness.

4.3.1.2.5 When the original wall thickness at manufacture is known, or the actual wall thickness. is measured, this thickness less one and one-half times the maximum measured pit depth shall be 1.5 mm or greater. If it is less, the cylinder shall be rejected.

4.3.1.2.6 Dents are of concern where they are near a weld. Where metal deformation is not sharp, dents of larger magnitude are not considered defects.

4.3.1.2.7 Where denting occurs so that any part of the deformation includes a weld, the maximum allowable dent depth shall be 6 mm.

4.3.1.2.8 When denting occurs so that any part of the deformation includes a weld, the cylinder shall be rejected if the depth of the dent is greater than one-tenth of the mean diameter of the dent.

4.3.1.2.9 Cuts, gouges, or digs reduce the wall thickness of the cylinder and in addition are considered to be stress raisers. Depth limits are set in this subparagraph; however, cylinders shall be rejected at one-half of the limit set whenever the length of the defects is 75 mm or more.

4.3.1.2.9.1 When the original wall thickness at manufacture is not known, and the actual wall thickness cannot be measured a cylinder shall be rejected if the cut, gouge, or dig exceeds one-half of the minimum allowable wall thickness as determined under items 4.3.1.2.4 and 4.3.1.2.5.

4.3.1.2.9.2 When the original wall thickness at manufacture is known, or the actual wall thickness is measured, a cylinder shall be rejected if the original wall thickness minus the depth of the defect is less than one-half of the minimum allowable wall thickness as determined by items 4.3.1.2.4 and 4.3.1.2.5.

4.3.1.2.10 To check for leaks, the cylinder shall be charged and carefully examined. All seams and pressure openings shall be coated with soap or other suitable solution to detect the escape of gas. Any leakage is cause for rejection.

4.3.1.2.11 Safety relief devices shall be tested for leaks before charged cylinder is shipped from the cylinder filling plant.

4.3.1.2.12 After fire damage, cylinders shall be carefully inspected for evidence of exposure to fire. Common evidence of exposure to fire are:

Charring or burning of the paint or other protective coat.

Burning or sintering of the metal.

Distortation of the cylinder.

Melted out fuse plugs.

Burning or melting of valve.

4.3.1.2.13 Cylinders are manufactured with a reasonably symmetrical shape. Cylinders which have definite visible bulges shall be removed from service and evaluated. Cylinders shall be rejected when a variation of 1 percent or more is found in the measured circumferences or in peripheral distances measured from the valve spud to the center seam (or equivalent fixed point).

4.3.1.2.14 Cylinders neck threads shall be examined whenever the valve is removed from the cylinder. Cylinders shall be rejected if the required number of effective threads are materially reduced, or if a gas tight seal cannot be obtained by reasonable valving methods. Gauges shall be used to measure the number of effective threads.

4.3.1.2.15 If the valve is noticeably tilted the cylinder shall be rejected.

4.3.1.2.16 The footring and headring of cylinders may become so distorted and defected through service abuse that they no longer perform their functions.

To cause the cylinder to remain stable and upright.

To protect the valve. Rings shall be examined for distortion; for looseness, and for failure of welds. Appearances may often warrant rejection of the cylinder.

4.3.1.3 Low-Pressure Cylinders Subject to Hydrostatic Testing

4.3.1.3.1 Cylinders covered in this subparagraph are low-pressure cylinders other than those covered in item 4.3.1.2. They differ essentially from such cylinders in that they require a periodic hydrostatic retest of 150% of design pressure and internal and external examination. Defect limits for the external examination are prescribed in item 4.3.1.2, with exceptions for aluminium cylinders shown in item 4.3.1.3.4.

4.3.1.3.2 Flammable gas cylinders shall be purged before being examined with a light. Lamps used for flammable gas cylinder inspection shall be explosion proof.

4.3.1.3.3 Cylinders shall be inspected internally at least every time the cylinder is periodically retested. The examination shall be made with a light of sufficient intensity to clearly illuminate the interior walls.

4.3.1.3.4 For aluminium cylinders the inspection requirements of subparagraphs 4.3.1.2 shall be met except as follows:

4.3.1.3.4.1 Aluminium cylinders shall be rejected when impairment to the surface (corrosion or mechanical defect) exceeds a depth where the remaining wall is less than three-fourths of the minimum allowable wall thickness.

4.3.1.3.4.2 Aluminium cylinders subjected to the action of fire shall be removed from service.

4.3.1.4 High-Pressure Cylinders

4.3.1.4.1 Cylinders shall be seamless; no longitudinal welding is permitted.

4.3.1.4.2 Cylinders shall be cleaned for inspection so that the inside and outside surfaces and all conditions can be observed. This shall include removal of scale and caked paint from the exterior and the thorough removal of internal scale. Cylinders with interior coating shall be examined for defects in the coating. If the coating is defective, it shall be removed.

4.3.1.4.3 An inspection light of sufficient intensity to clearly illuminate the interior wall is mandatory for internal inspection. Flammable gas cylinders shall be purged before being examined with a light. Lamps for flammable gas cylinder inspection shall be explosion proof.

4.3.1.4.4 When the original wall thickness of the cylinder is not known, and the actual wall thickness cannot be measured, the cylinder is rejected if corrosion exceeds 0.8 mm

in depth. This is arrived at by subtracting from the minimum allowable wall at manufacture, the limiting wall in service, to give the maximum allowable corrosion limit. When the wall thickness is known, or the actual wall thickness is measured, the difference between this known wall and the limiting value establishes the maximum corrosion figure.

4.3.1.4.5 Cylinders with general corrosion are evaluated by subjecting them to a hydrostatic test. If areas of pronounced pitting are included within the general corrosion, the depth of such pitting should also be measured (with the high spots of the actual surface as a reference plane) and the criteria established in the first example apply. The maximum corrosion limit shall be 0.8 mm when the wall thickness was not known.

4.3.1.4.6 Any defect of appreciable depth having a sharp bottom is a stress raiser and even though a cylinder may be acceptable from a stress standpoint, it is common practice to remove such defects. After any such repair operation, verification of the cylinder strength and structure shall be made by a hydrostatic test of 150 percent of design pressure.

4.3.1.4.7 Dents can be tolerated when the cylinder wall is not deformed excessively or abruptly. Dents are accepted up to a depth of about 1.5 mm when the major diameter of the dent is equal to or greater than 32 times the depth of the dent. Sharper dents than this are considered too abrupt and shall require rejection of the cylinder.

4.3.1.4.8 Cylinders with arc or torch burns shall be removed from service. Defects of this nature may be recognized by one of the following conditions:

Removal of metal by scarfing or cratering.

A sintering or burning of the base metal.

A hardened heat affected zone. A simple method for verifying the presence of small arc burns is to file the suspected area. The hardened zone will resist filing as compared to the softer base metal.

4.3.1.4.9 Cylinders are normally produced with a symmetrical shape. Cylinders with distinct visual bulges shall be removed from service until the nature of the defect is determined. Some cylinders may have small discontinuities related to the manufacturing process - mushroomed bottoms, offset shoulders, etc. These usually can be identified and are normally cause for concern.

4.3.1.4.10 Cylinders shall be carefully inspected for evidences of exposure to fire. See item 4.3.1.2.12.

4.3.1.4.11 Cylinder necks shall be examined for serious cracks, folds, and flaws. See item 4.3.1.2.14.

4.3.1.4.12 Cylinders shall be inspected internally at least every time the cylinder is periodically retested. This examination shall be made with a light of sufficient intensity to clearly illuminate the interior walls. A hammer test consists of tapping a cylinder a light blow with a suitably sized hammer. A cylinder, emptied of liquid content, with a clean internal surface, standing free, will have a clear ring. Cylinders with internal corrosion will give a duller ring dependent upon the

amount of corrosion and accumulation of foreign material. Such cylinders shall be investigated. The hammer test is very sensitive and is an easy, quick, and conveinent test that can be made without removing the valve before each charging.

4.3.1.5 Safety Relief Devices on Compressed Gas Cylinders

4.3.1.5.1 Compressed gas cylinder, portable tanks, and cargo tanks shall have pressure relief devices installed and maintained. Types of safety devices as covered by this subparagraph are the following:

Frangible disc.

Fusible plug or reinforced fusible Plug utilizing a fusible alloy with yield temperature not over 77°C, nor less than 69°C (74°C nominal).

Fusible plug or reinforced fusible plug utilizing a fusible alloy with yield temperature not over 104°C, nor less than 98°C (100°C nominal).

Combination frangible disc-fusible plug, utilizing a fusible alloy with yield temperature not over 77°C, nor less than 69°C (74°C nominal).

Combination frangible disc-fusible plug, utilizing a fusible alloy with yield temperature not over 104°C, nor less than 98°C (100°C nominal).

Safety relief valve.

Combination safety relief valve and fusible plug.

4.3.1.5.2 All safety devices covered by this subparagraph shall be approved.

4.3.1.5.3 Compressed gas cylinders, must be equipped with safety relief devices, and shall be considered acceptable when equipped with devices of proper construction, location, and discharge capacity.

4.3.1.5.4 Only replacement parts or assemblies provided by the manufacturer shall be used unless the advisability of interchange is proved by adequate tests.

4.3.1.5.5 When a frangible disc is used with a compressed gas cylinder, the rated bursting pressure of the disc shall not exceed the minimum required test pressure of the cylinder with which the device is used.

4.3.1.5.6 When a safety relief valve is used on a compressed gas cylinder, the flow rating pressure shall not exceed the minimum required test pressure of the cylinder on which the safety relief valve is installed and the reseating pressure shall not be less than the pressure in a normally charged cylinder at 54°C.

4.3.1.5.7 When fittings and piping are used on either the upstream or downstream side or both of a safety relief device or devices, the passages shall be so designed that the flow capacity of the safety relief device will not be reduced below the capacity required for the container on which the safety relief device assembly is installed, nor to the extent that the operation of the device could be impaired. Fittings, piping, and method of attachment shall be designed to withstand normal handling and the pressures developed when the device or devices function.

4.3.1.5.8 No shutoff valve shall be installed between the safety relief devices and the cylinder.

4.3.1.5.9 As a precaution to keep cylinder safety relief devices in reliable operating condition, care shall be taken in the handling or storing of compressed gas cylinders to avoid damage. Care shall also be exercised to avoid plugging by paint or other dirt accumulation of safety relief device channels or other parts which could interfere with the functioning of the device. Only qualified personnel shall be allowed to service safety relief devices.

4.3.1.5.10 Each time a compressed gas cylinder is received at a point for refining, all safety relief devices shall be examined externally for corrosion, damage, plugging of external safety relief device channels, and mechanical defects such as leakage or extrusion of fusible metal. If there is any doubt regarding the suitability of the safety relief device for service, the cylinder shall not be filled until it is equipped with a suitable device.

4.3.1.6 Safety Relief Devices for Cargo and Portable Tanks Storing Compressed Gas

4.3.1.6.1 Safety relief valves shall be set to start-to-discharge at a pressure not in excess of 100 percent of the design pressure of the container nor less than the design pressure of the container except as follows:

If an overdesigned container is used, the set pressure of the safety relief valve may be between the minimum required design pressure for the lading and 110 percent of the design pressure of the container used.

For carbon dioxide (refrigerated), nitrous oxide (refrigerated), and pressurized liquid argon, nitrogen and oxygen, there shall be no minimum set pressure.

4.3.1.6.2 Only replacement parts or assemblies provided by the manufacturer of the device shall be used unless the suitability of interchange is proved by adequate tests.

4.3.1.6.3 Safety relief valves shall have direct communication with the vapor space of the container.

4.3.1.6.4 Any portion of liquid piping or hose which at any time may be closed at each end must be provided with a safety relief device to prevent excessive pressure.

4.3.1.6.5 The additional restrictions of this subparagraph apply to safety relief devices on containers for carbon dioxide or introus oxide which are shipped in refrigerated and insulated containers. The maximum operating pressure in the container may be regulated by the use of one or more pressure controlling devices, which devices shall not be in lieu of the safety device required in item 4.3.1.5.1.

4.3.1.6.6 All safety relief devices shall be so installed and located that the cooling effect of the contents will not prevent the effective operation of the device.

4.3.1.6.7 In addition to the safety relief devices required in item 4.3.1.5.1 each container for carbon dioxide may be equipped with one or more frangible disc safety relief devices of suitable design set to function at a pressure not exceeding two times the design pressure of the container.

4.3.1.6.8 When storage containers for liquefied petroleum gas are permitted to be shipped, they must be equipped with safety relief devices in compliance with the requirements for safety relief devices on above-ground containers.

4.3.1.6.9 When containers are filled by pumping equipment which has a discharge capacity in excess of the capacity of the container safety relief devices, and which is

capable of producing pressures in excess of design pressure of the container, precautions should be taken to prevent the development of pressure in the container in excess of 120 percent of its design pressure.

4.3.1.6.10 This additional requirement applies to safety relief devices on container for liquefied hydrogen, nitrogen, and oxygen. The liquid container shall be protected by one or more safety relief valves and one or more frangible discs.

4.3.1.6.11 Safety relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent any impingement of escaping gas upon the container. Safety relief devices shall be arranged to discharge upward except this is not required for carbon dioxide, nitrous oxide and pressurized liquid argon, nitrogen, and oxygen.

4.3.1.6.12 No shutoff valves shall be installed between the safety relief devices and the container except, in cases where two or more safety relief devices are installed on the same container, a shutoff valve may be used where the arrangements of the shutoff valve or valves are such as always to insure full required capacity flow through at least one safety device.

4.3.1.6.13 Care shall be exercised to avoid damage to safety relief devices. Care shall also be exercised to avoid plugging by paint or other dirt accumulation of safety relief device channels or other parts which could interfere with the functioning of the device.

4.3.1.6.14 Only qualified personnel shall be allowed to service safety relief devices. Any servicing or repairs which require resetting of safety relief valves shall be done only by or after consultation with the valve manufacturer.

4.3.1.6.15 Safety relief devices shall be examined periodically externally for corrosion, damage, plugging of external safety relief device channels, and mechanical defects such as leakage or extrusion of fusible metal. Valves equipped with secondary resilient seals shall have the seals inspected periodically. If there is any doubt regarding the suitability of the safety relief device for service the container shall not be filled until it is equipped with a suitable safety relief device.

4.3.2 Compressed Gas Equipment and Piping

4.3.2.1 General. Air receivers shall be so installed that all drains, handholes, and manholes therein are easily accessible. Air receivers shall be supported with sufficient clearance to permit a complete external inspection and to avoid corrosion of external surfaces. Under no circumstances shall an air receiver be buried underground or located in an inaccessible place.

4.3.2.2 Drains. A drain pipe and valve shall be installed at the lowest point of every air receiver to provide for the removal of accumulated oil and water. The drain valve on the air receiver shall be opened and the receiver completely drained frequently and at such intervals as to prevent the accumulation of liquid in the receiver.

4.3.2.3 Gages and Valves

4.3.2.3.1 Every air receiver shall be equipped with an indicating pressure gage (readily visible) and with one or more spring-loaded safety valves. The total relieving capacity of such safety valves shall be such as to prevent pressure in the receiver

from exceeding the maximum allowable working pressure of the receiver by more than 10 percent.

4.3.2.3.2 No valve of any type shall be placed between the air receiver and its safety valve or valves except as provided by item 4.1.8.8.

4.3.2.3.3 Safety appliances, such as safety valves, indicating devices and controlling devices, shall be constructed, located, and installed so that they cannot be readily rendered inoperative by any means, including the elements.

4.3.2.3.4 All safety valves shall be tested at regularly scheduled intervals to determine whether they are in good operating condition.

4.3.2.4 Gas Compressors and Engines

4.3.2.4.1 When a gas compressor plant or a gas processing plant discharges gas into a line to which other sources of gas supply are connected there shall be a valve installed in the plant's discharge line, or lines, for the purpose of automatically preventing the return flow of gas. The valve shall, where practical, be located outside of the plant but within a reasonable distance of the plant.

4.3.2.4.2 Gas compressor discharge lines shall have a pressure-relieving safety device. There shall be no valve located between the pressure relieving safety device and the cylinder or cylinders it is to protect. The pressure-relieving safety device shall be set to open at a pressure not to exceed the maximum allowable working pressure of the cylinder. The relieving capacity of the pressure- relieving safety device shall be such as to prevent a rise of pressure in the cylinders of more than 10 percent above their maximum allowable working pressure.

4.3.2.4.3 Where a gas compressor pressure-relieving safety device discharges into the atmosphere, the discharge outlet shall be located outside of the compressor building and if it discharges adjacent to the building, it shall have the discharge outlet located above the compressor building eaves.

4.3.2.4.4 Where hazardous quantities of liquid may be present in the incoming gas to compressors, an inlet scrubber shall be provided and a device installed thereon to give either audible warning or shut down the compressors in case the liquid in the scrubber exceeds a predetermined level.

4.3.2.4.5 Gas lines which enter plants, and which are connected to compressor intakes, shall be provided with shut-off valves in a safe location.

4.3.2.4.6 While maintenance work of a nature requiring the opening of lines or equipment containing gas is being performed on a compressor or its suction or discharge piping, employees shall be protected from being endangered by escaping gas by closing and locking of the valves in the intake and discharge lines. If the closing and locking of the lines is inadequate, the lines shall be blinded, or other equally effective means taken to prevent the escape of gas,

4.3.2.4.7 Air and gas compressor engines of over 30 horsepower shall be provided with means other than manual for starting, providing that manual starting may be used in emergencies.

4.3.2.4.8 Internal combustion engine ignition systems or wires shall not be manipulated in such a manner that an open spark may be produced in a gas compressor building

or in buildings where there may be an accumulation of flammable gases unless tests indicate that the flammable gas or vapor contents of the atmosphere is less than 25 percent of the lower explosive limit.

4.3.2.4.9 Cylinder cocks of internal combustion engines shall not be opened at any time when a flame or spark may be discharged from the cylinder cock into a gas compressor room or in buildings where there may be an accumulation of flammable gases unless tests indicate that the flammable gas or vapor content of the atmosphere is less than 25 percent of the lower explosive limit.
Note: The attention of employees is directed to the fact that items 4.3.2.4.8 and 4.3.2.4.9 prohibit the making of engine tests that create a source of ignition, except after having established, by testing, that it is safe to do so.

4.3.2.4.10 In addition to the throttle valve, other means shall be provided by the use of one or more valves, blinding, or other provisions giving equivalent safety, to prevent fuel gas entering cylinders and actuating moving parts while maintenance work is being performed upon an internal combustion engine, or upon the equipment connected to and driven by the engine, when such maintenance work would otherwise expose the employee to possible injury.

4.3.2.4.11 The main fuel gas line to the gas compressor engines and other internal combustion engines located in gas compressor buildings, shall be equipped with a suitable master shut-off valve located outside the building.

4.3.2.4.12 There shall be a check valve provided in the engine or in the air-starting line adjacent to each internal combustion engine cylinder using compressed air as the means of starting.

4.3.2.4.13 The compressed air supply for starting an engine shall be prevented from so functioning while maintenance work is being performed on an idle internal combustion engine, or on the equipment connected to and driven by the engine, when such maintenance work is of a nature that employees may be endangered and should starting compressed air cause the engine to move or turn over. This shall be accomplished by one of the following means.
Breaking the air starting line union and separating the pipe.
Having two closed valves in the air starting line with an open tee between them having a discharge capacity equal to the capacity of the air starting line.
Or other means may be used which give equally effective positive protection as mentioned above.

4.3.2.4.14 An overspeed trip or an overspeed regulator operating to cut off the ignition shall be installed, in addition to the governor controlling the fuel supply, on internal combustion engines driving gas compressors. The overspeed trip or overspeed regulator shall be maintained in an operative condition and be so installed and adjusted as to prevent the engine from overspeeding.

4.3.2.5 Cylinder Marking. All gas cylinders shall be legibly marked with the international chemical formula. In Arabic notation the name of the gas shall also be marked with one or more of the following applicable words:
Flammable;
Toxic;
Corrosive;
Inert.